DOCUMENT RESUME

ED 213 857 CE 031 480

TITLE	Warehousing Storage and Retrieval Safety. Module SH-23. Safety and Health.
INSTITUTION	Center for Occupational Research and Development, Inc., Waco, Tex.
SPONS AGENCY	Office of Vocational and Adult Education (ED). Washington, DC. Div. of National Vocational Programs.
PUB DATE	81
CONTRACT	300-79-0709
NOTE	40p.; For related documents see CE 031 450-507.
AVAILABLE FROM	The Center for Occupational Research and Development, 601 Lake Air Dr., Suite C, Waco, TX 76710 (Instructor Guides, $9.75 each; Learning Modules, $3.00 each. Entire set of Learning Modules available as two subsets: SH-21, SH-41, SH-43, SH-45, and SH-48, $12.00; remaining 45 modules, $97.50).
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; *Health Education; Learning Activities; Learning Modules; *Lifting; Postsecondary Education; *Safety Education; Secondary Education; *Storage; *Vocational Education; *Warehouses
IDENTIFIERS	*Occupational Safety and Health

ABSTRACT

This student module on warehousing storage and retrieval safety is one of 50 modules concerned with job safety and health. This module discusses methods of storage and retrieval that minimize lifting and twisting that can lead to employee injuries. Following the introduction, 13 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Describe the correct procedures for safe lifting). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

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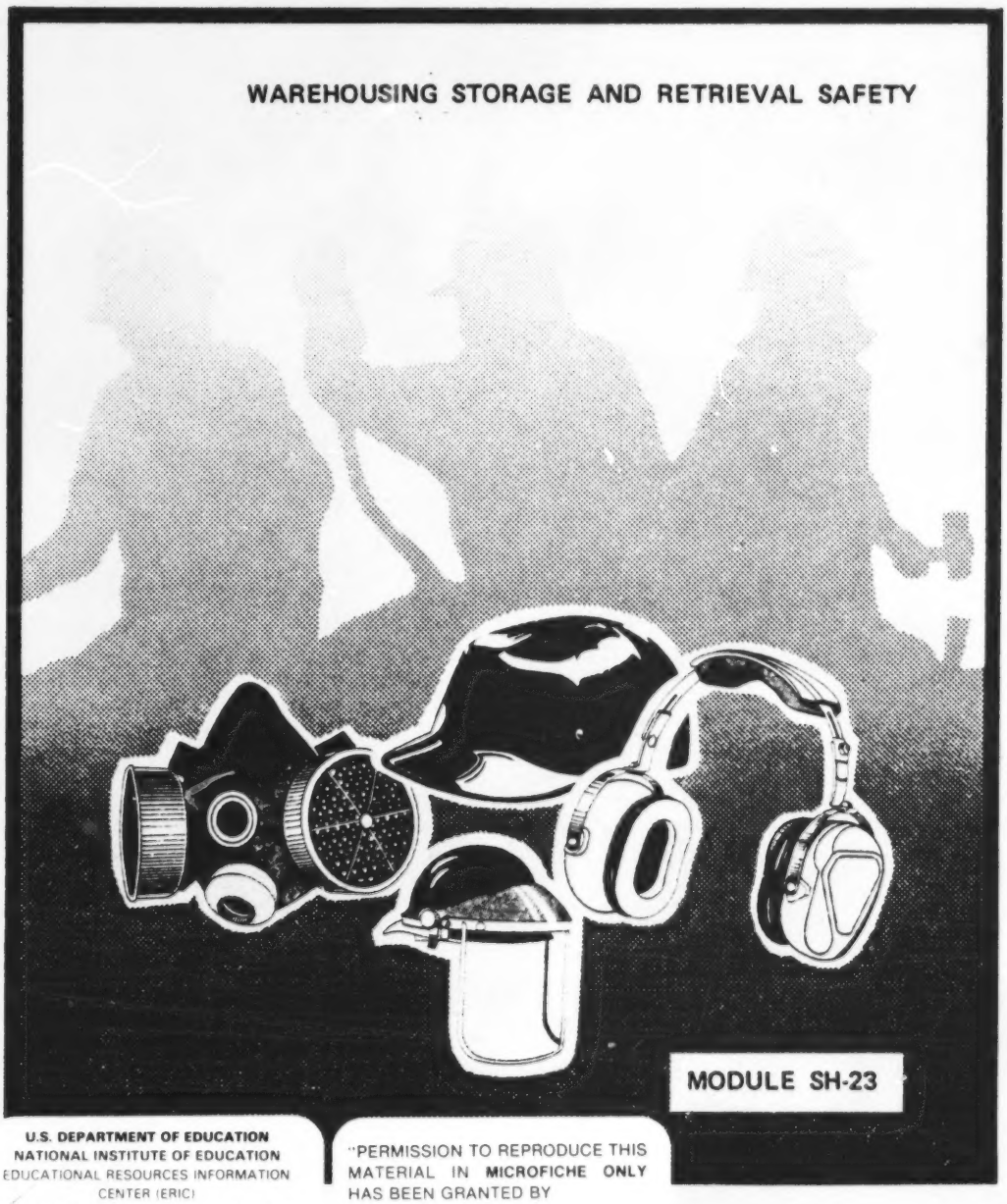
SAFETY AND HEALTH

WAREHOUSING STORAGE AND RETRIEVAL SAFETY



MODULE SH-23

ED 31480

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INTRODUCTION

Virtually all raw materials, work-in-process, and finished goods are moved and stored several times from the beginning of the manufacturing process to the time they reach the consumer. Consequently, the subject of warehouse storage and retrieval safety is an extremely broad one. Materials are handled in a variety of ways based on weight, size, type of material, distance moved, and other factors. Other elements that affect the way in which materials are handled include economics, available space, environmental quality, bulk, and quantity.

The methods and procedures used to move thousands of materials varies further by company, plant, and department. The managers of modern automated plants have found that while some accident problems are minimized through automation, other safety problems are increased.

A study of 548,000 worker compensation claims by the Travelers Insurance Company between 1974 and 1977 showed that 24% of the injuries resulted from the movement of materials and equipment. Experience shows that accidents can be reduced by a careful study of past injuries and by analyzing work and storage methods. Other elements requiring attention are:

- Selecting equipment and retrieval methods to reduce lifting and twisting.
- Training and supervising workers to help them perform efficiently.
- Maintaining good housekeeping to minimize slips, falls, and hazards.

To the extent possible, automated handling systems should be installed and physical efforts reduced if worker injuries are to be avoided. The escalating worker compensation costs for long-term disabilities related to back strains, sprains, and hernias make automated handling systems cost effective.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List and define five common types of injury that can result from warehouse storage and retrieval. (Page 3)

2. List four factors that should be considered in "sizing up the job" of material handling. (Page 5)
3. Describe the correct procedures for safe lifting. (Page 7)
4. Name three items of personal protective equipment used in handling and storing materials. (Page 10)
5. List five items with specific shapes that require special handling, and describe special handling procedures for each. (Page 14)
6. Provide a brief description of the correct use of the following accessories for manual lifting: bars, hooks, roller, jacks, hand trucks, and pallets. (Page 16)
7. Identify the hazards of three types of powered material handling equipment. (Page 20)
8. Discuss the impact of good housekeeping and orderly planning of storage areas on fire protection and emergency evacuation. (Page 22)
9. Describe the general requirements for floors, ramps, and aisles in a warehouse. (Page 24)
10. Name the source of lighting standards for industrial lighting. (Page 25)
11. Compare the use of tracks and bins for warehouse storage. (Page 26)
12. Cite specific storage procedures for the following: boxes and cartons, barrels and kegs, rolled paper and reels, compressed gas cylinders, uncrated stock, and hazardous materials. (Page 27)
13. Briefly describe stock picking and carloading safety. (Page 32)

OBJECTIVE 1: List and define five common types of injury that can result from warehouse storage and retrieval.

Workers who handle and store products are subject to a higher than usual rate of strains, sprains, hernias, wounds, and fractures. Accident studies show that up to 45% of work accidents result from activities involving material handling and the storage of raw materials, work-in-progress, finished goods, and scrap.

An analysis of 240 injuries that caused at least seven days disability, and that occurred in the paperboard container industry in Michigan during 1973, revealed that the most prevalent type of accident was from lifting. Lifting accidents accounted for 84 cases, or 35% of the total. Sixty-seven of the injuries in the study related to back disabilities. All of these material handling accidents mean pain and suffering to those involved, and some may require medical attention and hospitalization. The most common injuries resulting from warehouse storage and retrieval are described below.

Strains result from stretching a muscle beyond its proper limit. Most workers occasionally experience muscle strains to arms, legs, or back. The aging process, over-exertion, lack of exercise, lack of rest, and nutritional deficiencies may be a factor in back pain and discomfort. Pulled ligaments and strained tendons often result from innocent acts that may not relate to lifting heavy loads. The problem of muscle strain is aggravated for the industrial worker who must perform physical work while experiencing pain. Frequently, such work effort becomes impossible to carry out and medical treatment is required. Muscle relaxants and heat treatments are frequently prescribed to reduce pain and return the worker to the job.

A sprain is a weakening of a joint and related muscles by sudden or excessive exertion. Avoidance of sudden movement and development of a smooth rate and rhythm in work will minimize sprains. Jumping, falling, and misstepping are frequent causes of sprains. Reaching for a heavy load above shoulder height or from an awkward position can result in a sprain to the back or arms. Storage areas can and should be arranged so that difficult

lifts are unnecessary. Workers should be instructed to avoid twisting while carrying a heavy or bulky load.

A hernia is the protrusion of an organ (often the intestines) because of a pulling apart of the body's muscle lining. Hernias can be caused by moving things in the wrong way.

Fractures are injuries in which bones are broken or cracked. A majority of fractures result from being struck by a heavy or moving object, from jamming fingers, or from dropping objects on toes. Examples of accidents include the following:

- A powered vehicle used for the movement of material strikes a worker.
- A heavy object falls from an unstable stack of materials onto a worker below.
- Two power trucks collide in a warehouse.

Warning devices, mirrors, stable stacking practices, housekeeping, operator training, and well-maintained equipment will reduce fractures caused by power trucks.

Cuts and bruises, or wounds, are caused by workers bumping against racks, sharp edges of bins, pallets, or materials. Personal protective equipment such as safety hats, gloves, shoes, and eye protection may reduce injuries. Stable storage methods will prevent injuries resulting from a falling or shifting load.

ACTIVITY 1:*

List and define briefly five common types of injury that can result from warehouse storage and retrieval.

1. _____
2. _____
3. _____
4. _____
5. _____

*Answers to Activities appear on page 35.

OBJECTIVE 2: List four factors that should be considered in "sizing up the job" of material handling.

A safety specialist often works to reduce on-the-job injuries through a careful analysis of accident records. A study of injuries in a particular workplace will generally indicate where the greatest hazards exist and will direct the specialist toward solutions for worker and management errors. The following steps are usually taken by management to improve safety performance:

- Determining if the job or task can be changed to reduce physical effort and improve handling efficiency.
- Checking to be sure that there are no uncorrected hazards, poor housekeeping practices, or training requirements that management can change.

On a day-to-day basis, supervisors as well as workers have to make decisions about how to move loads safely. In doing so, they need to consider (1) the size, shape, and condition of the load, (2) the capability required to lift the load, including whether or not mechanical aids, or more than one person will be needed to do the job, (3) the path or route that the load will travel, and (4) the personal protective equipment that may be required to safely handle the load. (See Figure 1.)

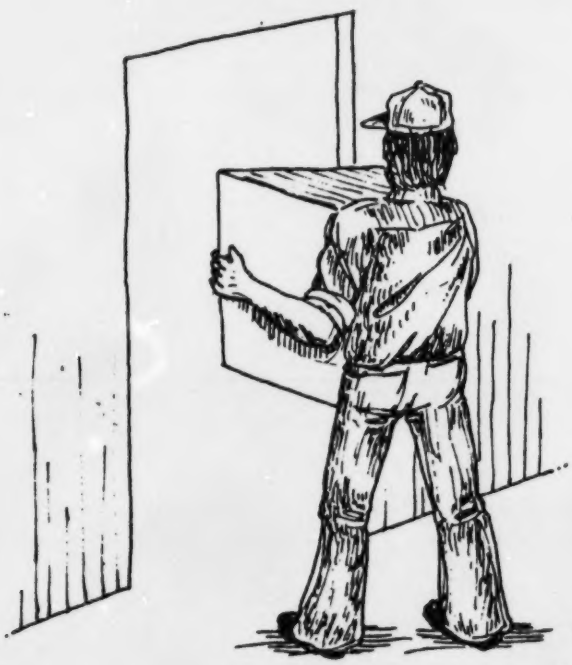


Figure 1. Sizing up the load.

The load to be moved should be inspected for weight, slivers, nails, sharp edges, or a weak bottom. The load may be

slippery, hard to grip, or awkward to handle. If the object is oddly shaped, the worker should look over it to see where and how to hold it firmly. "Sizing up the load" before the move includes checking whether or not the worker can see over and around the load. Grease and oil should be removed from the load to make the load as dry as possible.

Material handling and storage injuries frequently result from errors in judgement regarding the strength required to move the load. Workers sometimes attempt to lift loads beyond their capacity in order to display their strength or to prove their competency.

When a load is too heavy for a one-person lift, the worker must obtain help. Some authorities suggest that a worker should not lift more than one-half of his or her body weight. However, guides on weight-lifting limitations are difficult to provide because physical condition, strength, age, and sex can each make a critical difference in determining how much weight someone can safely lift. The judgment and experience of supervisors and workers must be considered when deciding if a two-person lift is necessary.

Before the lift, workers must determine if the path over which the object will be moved is smooth and unobstructed. Repetitive lifting is usually performed in an area familiar to the individual doing such work, but unusual lifts or movements of equipment over unfamiliar areas require checking clearances of stairs, doorways, and halls to the final destination. A large number of injuries occur to worker's hands and fingers during lifting; many of these result from workers' failure to note clearances and to avoid pinch points.

When moving and storing raw materials, work-in-progress, and finished goods, workers require personal protective equipment to perform their work safely. Where heavy objects are being carried, or there is the possibility of a foot being struck by powered equipment, foot protection is necessary. The handling of certain industrial chemicals, pesticides, acids, or caustics may necessitate eye protection. Failure to wear hand and body protection may result in injuries to the skin because of exposure to chemicals, physical abrasion, or pinching. Slip-resistant gloves may be appropriate for some jobs. Where objects could fall from stacks or bins, safety hats may be required. Unfavorable environmental conditions such as wet, slick, or high-temperature storage areas require specialized personal protective equipment.

If material is being moved in an oxygen deficient or contaminated area, respiratory protection may be necessary.

Furnishing certified equipment that meets the requirements of the American National Standards Institute is part of the employer's responsibility. Supervisors must insist that it be worn, kept clean, and maintained so it will provide the protection for which it is intended. Finally, employees must participate in their own protection by conscientiously wearing personal protective equipment.

ACTIVITY 2:

List four factors that should be considered in "sizing up the job" in material handling.

1. _____
2. _____
3. _____
4. _____

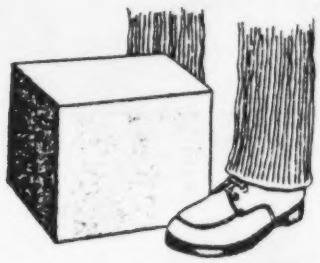
OBJECTIVE 3: Describe the correct procedures for safe lifting.

Seventeen million Americans suffer recurrent back pains that prompt more than two doctor visits per person each year. Forty-seven percent of those experiencing back pain are between 21 and 45 years of age. The over 30-year-old age group is three times more likely to suffer back pain than the under 30 age group.

Many back problems result from improper lifting. Bending forward or to the side creates an unstable posture, since the weight of the upper trunk is approximately 70% of body weight. For instance, in a 150-pound person, the trunk weighs about 105 pounds. If a 50-pound object is picked up, the worker is placing 155 pounds of lifting effort on the lower spine. Placing undue pressure and strain on the lower back and spine may result in injury, especially if aging, physical condition, and fatigue are factors, too.

The physical differences of workers make it impossible to list specific weight limitations for lifting. In many cases, however, back injuries are caused not by the weight of the load, but by improper lifting techniques.

Workers must be trained in the correct way to lift if injuries are to be avoided. When loads are being lifted from floor level, workers must be taught to bend their knees. The importance of using powerful leg muscles, rather than exerting unnecessary strain on back muscles and discs in the lower spine, must be emphasized. After sizing up the job, workers should follow the procedures shown in Figure 2 to safely lift the load. When



a. Position feet near load; one foot beside the load, the other behind it.

b. Squat close to load, keeping back straight.

c. Grasp load at diagonally opposite corners, using whole hand.

d. Tuck in chin, and breathe in.

e. Lift with legs; keep back straight.

f. Do not jerk or twist and keep load close to body.

Figure 2. How to lift.

repetitive lifting is required, workers should do a few warm-up exercises before starting work. It is important for workers to develop a smooth rate and rhythm while performing repetitive lifting tasks.

TEAM LIFTING AND CARRYING

When two workers lift the same load, they must assume a proper lifting posture and lift as a team. If one worker drops or lowers the load unexpectedly, the result could be serious injury to the other worker. Workers carrying a long load should be of approximately the same height. This provides better weight distribution and improved safety.

Carrying lengths of material can present problems if workers attempt to walk on opposite sides of the load. In such a position, neither person could jump clear of the load if it were dropped. Walking on the same side of the load, in step, puts workers in line and reduces chances of injury. One worker should call signals so there is no misunderstanding on how the lift will be completed. Shoulder pads may even be necessary to avoid injury during repetitive carries are to be made with the object resting on the workers shoulders.

ACTIVITY 3:

(Choose the best answer.)

1. The real work in lifting should be done by which part of the body:
   a. Back and spine?
   b. Legs?
   c. Torso?
2. Two person lifting can present problems if:
   a. Both persons are the same height.
   b. Workers try to walk on opposite sides of a long load.
   c. One person calls signals.
   d. Shoulder pads are worn.

OBJECTIVE 4: Name three items of personal protective equipment used in handling and storing materials.

A study of 7,460 medical injuries reported to the Travelers Insurance Company during 1975 disclosed that 11% of the injuries resulted from personal prtoective equipment not being used. According to the 1980 edition of the National Safety Council's Accident Facts booklet, 22% of all injuries occur to worker's eyes, and 7% to feet and toes. Many of these injuries could have been avoided if workers had worn protective equipment. Personal protective equipment (PPE) should be thought of as the "last thin line of defense." Failure to wear protective equipment exposes the worker to hazards.

OSHA (Occupational Safety and Health Administration) regulations state that personal protective equipment required if there is a reasonable probability of injury. Employers are responsible for seeing that personal protective equipment is worn where needed. Many employers provide personal protective equipment; others share the cost of such equipment with the worker, and some require workers to provide their own PPE. The prudent employer evaluates each job to determine where protection is necessary and what kind of protection is appropriate to the job. Once determinations have been made, a consistent policy concerning the use of personal protective equipment be followed.

GLOVES AND HAND PROTECTORS

Experience shows that hand protection through the use of gloves or palm guards reduces cuts, blisters, burns, and dermatitis. There are numerous types of hand protection from which workers and employers can select effective and comfortable protection. Glove materials include canvas, latex, rubber, neoprene, vinyl-impregnated, stanzoil, leather, butyl, plastic-coated, and nylon. Varied styles designed to meet every conceivable purpose are offered by glove suppliers.

In operations involving wood, metal, glass, or paper, or where sharp edges pose a hazard, various types of hand protection are available. In foundries, steel mills, and salvage operations, leather gloves may be

required. Metal mesh guards are used in the meat processing industry. Where flame and heat are a factor, various types of heat-resistant gloves are available (asbestos should be avoided).

Chemical hazards may require rubber, neoprene, or plastic gloves. Wrists and arms may require protection from hot wax, high-temperature materials, solvents, or metal chips. Such protection is provided by arm protectors or gauntleted gloves (those that extend over the wrist and lower arm).

SAFETY SHOES AND LEG PROTECTION

In 1979, the National SafetyuCouncil reported that American workers suffered 160,000 foot and toe injuries. Safety experts have long maintained that foot protection programs were effective in reducing injury to feet and toes. Facts show that the increased use of foot protection during the 1970s has substantially reduced the number of foot and toe injuries. According to 1972 National Safety Council statistics, workers in the American industries suffered 240,000 foot and toe injuries. Because of the substantially increased use and the cost sharing of safety shoe purchases, workers are suffering 80,000 fewer foot and toe injuries than they were seven years ago.

Five principal types of safety shoes are available to protect against specific conditions encountered in industry. They are safety-toe shoes, conductive shoes, electrical hazard shoes, explosives-operations (nonsparking) shoes, and foundry (molders) shoes. Of the five types, the first three are the most common and will be discussed here.

Most foot and toe injuries result from the dropping of heavy objects that crush or cut ordinary work shoes. Safety shoes that meet American National Standards Institute (ANSI) Standard Z 41.1-1967 protect against all but the most severe industrial hazards. Suppliers provide an excellent assortment of attractive, comfortable shoes for men and women. The variety of styles permits proper fitting for normal feet. Many companies maintain shoe departments in their plants, or provide safety shoemobile service to ensure convenient access to safety shoes.

Safety toe footwear has been divided into three classifications; each class offers a different degree of strength, or resistance to impact and compression. The strongest shoe is classified 75, the next strongest is 50, and

the least resistant to impact is 30. The numbers refer to the foot-pounds of impact that the shoe can successfully resist.

Special foot, toe, and leg protection is available, also. Steel foot guards are light enough to be worn without discomfort or loss of efficiency. These protectors have rubber toe clips, a cross bar, and leather straps. Foot guards are recommended where maximum foot protection is necessary. Toe guards fill a demand for toe protection in occupations where hazards to toes exist, or where safety shoes cannot be worn because of a foot disability. Such protectors fit any shoe and afford maximum protection.

Combinations of foot and shin guards are available for jobs where the movement of heavy material could cause serious foot and leg injuries. Heavy plastic or aluminum shin guards are formed to the contour of the leg, with reinforcing ribs for added strength and rigidity. Sponge pads are fastened at the top and bottom of the inside of the guard for wearer comfort.

Certain industries may require special products for the protection of workers' feet and legs. For example, conductive soles and heels drain off static charges and thus avoid the creation of static electricity in locations with a fire or explosion hazard. Electrical hazard shoes are made of leather. No metal is used in their construction except in the box, which is insulated from the shoe. Chain saw leg guards are attached to the trouser leg of workers using chain saws. These guards are made of three inner layers of propylene cloth which prevents the chain saw from cutting. These lightweight guards can easily be attached to trousers and detached for laundering.

EYE PROTECTION

Federal safety laws state that employers must require workers to wear suitable eye and face protection where eye injuries may occur. Protection is needed where hazards of flying particles, liquids, welding, and radiation exist. Material handling and storage conditions as well as the record of past injuries must be examined to determine where hazards exist and protection is needed.

A typical safety policy insists that designated jobs such as baling, banding, cutting bands or wires, grinding, nailing, riveting, handling chemicals, using compressed air, welding, placing wax in melt tanks, maintenance,

skid building, and woodworking require eye protection. Some companies require 100% eye protection because hazards in the workplace make such protection necessary.

When required, eye and face protection must meet the requirements of ANSI Standard Z 87.1-1979. Real safety glasses will carry the Z87 emblem. This standard provides for the design, construction, testing, and use of goggles, spectacles, and face protective devices. Suppliers offer a wide range of styles, models and types of protection. Arrangements must be made for the selection, fitting, and use of eye protective wear, since this will help ensure that workers wear protection.

In addition to the human loss, compensation costs resulting from the loss of an eye are substantial. The cost of impact-resistant safety glasses ranges from $5 to $20 a pair. Safety specialists agree that this is a cost-effective preventive measure for prudent businesses to include in their accident prevention programs.

Educational programs, access to protection, and sharing the costs of safety glasses will reduce the 110,000 eye injuries suffered each year by American workers. The use of eye, hand, foot, and head protection holds the promise of reducing injuries to workers.

ACTIVITY 4:

1. Circle the statement that is not true about personal protective equipment (PPE).
   a. PPE should be thought of as the last thin line of defense.
   b. Employers must furnish all PPE.
   c. Employers must ensure that workers use PPE where it is needed.
   d. PPE must be selected for the specific job situation for which it will be used.
2. List five types of safety footwear.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

3. (Fill in the blank.)

   a. The strongest safety-toe footwear is Class ____ (number).

   b. Eye and face protection must meet the ANSI Standard _____.

OBJECTIVE 5: List five items with specific shapes that require special handling, and describe special handling procedures for each.

Workers engaged in warehouse storage and retrieval handle and store numerous shapes, materials, and types of packaging. A few types of packaging are described below.

BOXES, CARTONS, AND SACKS

When moving these objects, workers should get close to the object, bend the knees, and grasp the load at diagonally opposite corners before lifting Sacked materials should be rested on the hip and swung to the shoulder. Placing one hand on the hip lets the sack rest partially on the shoulder and on the arm and back. The other hand is used to steady the sack. When the sack is lowered, it should be swung slowly from the shoulder until it rests against the hip.

Figure 3. A lifter bar, or drum lifter.

BARRELS AND DRUMS

Handling barrels and drums safely requires proper equipment and training. When moving a relatively small drum, a lifter bar (Figure 3) provides powerful leverage and control of the drum. If the barrel must be rolled to a destination, the worker should push against its sides. Gloves and safety shoes should be worn, and care should be exercised so that the drum is always under control.

On an incline or a ramp, ropes should be used to keep the drum under control. Workers must avoid pinch points by checking clearances at doors, ramps, and aisles. Where barrels or drums are handled on a regular basis, accessories for power lift trucks will remove the back-breaking labor from this type of work.

SHEET METAL

Handling sharp edges of metal requires that workers wear protective leather gloves. Gauntlet-type gloves or wrist protectors provide additional protection. Safety shoes, eye protection, and hard hats may be necessary. Mechanical lift equipment is available for the lifting of sheet metal and steel.

WINDOW GLASS

Workers who handle glass must wear leather gloves with wrist and arm protection. A leather apron, safety shoes, and ankle protection are also necessary. Workers should carry one sheet of glass at a time and move carefully. During manual lifts, the bottom edge of the glass should rest in the palm of the hand with the other hand steadying the top of the sheet. Glass should not be carried under the arm because a fall could cause the glass to cut an artery. Glass marked with tape will reduce the hazard of someone accidently walking into it. Mechanical suction cup equipment and A-frame trucks are used to reduce the danger of handling glass.

LONG AND IRREGULAR OBJECTS

Long pieces of bar stock, pipe, ladders, and lumber should be carried on the shoulder. The front portion should be held to prevent the striking of other workers. When irregular objects are transported, it is important to "size up the lift" and determine the best way to handle the object. Selecting the right tools, rollers, jacks, and special equipment before attempting the lift will avoid injuries.

SCRAP MATERIALS

Workers who handle sharp or irregular materials and metals must wear gloves, safety shoes, safety hats, and body and eye protection. Shoes with steel sole plates will prevent puncture wounds.

HEAVY, ROUND, OR FLAT OBJECTS

The movement of heavy machinery requires special skill. Such moving is usually performed by moving companies that have special equipment. Heavy-duty cranes, rollers, low boys, and jacks reduce or remove the physical effort during such moves. Floor load limits, clearances in relation to power lines, doorways, and equipment must be determined before the move commences.

ACTIVITY 5:

(Mark each item true or false.)

_____ 1. Glass is most safely carried under the arm and with leather gloves.

_____ 2. Sacked materials should be rested on the hip and then swung to the shoulder.

_____ 3. Safety shoes should always be worn for the moving of barrels and drums.

_____ 4. Long pieces of bar stock should be carried at the hip.

_____ 5. Workers who handle sharp or irregular metals must wear gloves, safety shoes, safety hats, body and eye protection.

OBJECTIVE 6: Provide a brief description of the correct use of the following accessories for manual lifting: bars, hooks, rollers, jacks, hand trucks, and pallets.

While manual lifting has been reduced substantially during the last 30 years, some tasks must still be performed manually. Tools to assist

Figure 4. A pry bar will assist in the movement of a heavy object.

workers performing manual lifting tasks include bars, hooks, rollers, jacks, hand trucks, and pallets.

TOOLS THAT AID IN MANUAL LIFTING

Pry bars are used to start movement, to free a heavy object, or to assist in the movement of heavy rolls. (See Figure 4.) Bars with a dull edge make it difficult to get a good bite under the object being moved. Bars can slip and should not be used to move railcars, since nonslipping car movers can accomplish the job with greater efficiency and safety.

Training is required for workers who use hand or packing hooks (Figure 5). If the hook is carried on the belt, the point should be protected. Hooks must be kept sharp, have splinter-free handles, and be inspected daily.

Heavy, bulky objects may be moved with the assistance of rollers (Figure 6). Since fingers and toes can be pinched or crushed between rollers and the floor, rollers should extend beyond the load being transported.

The capacity plate of a jack (Figure 7) should be checked before use to be sure that it will support the load being moved. Jacks must be inspected

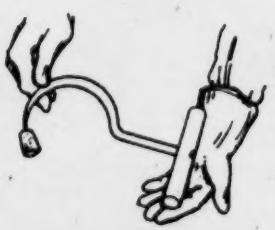


Figure 5. Packing hook.

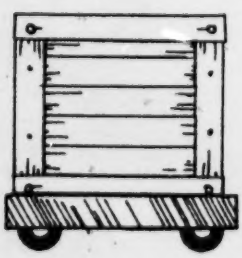


Figure 6. Rollers.

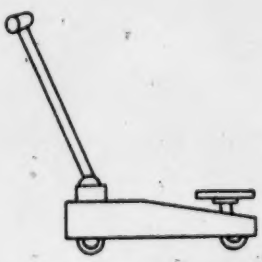


Figure 7. Jack.

and if hydraulic fluid is leaking the jack should not be used. Floors where jacks are used must be level, and load limits must be observed. Two-inch hardwood shims should be used to keep the jack head and the load from contact.

Figure 8. Two-wheeled truck with hand brake, being pushed down slope of dock plate.

HAND TRUCKS

Various types of trucks are available for moving items such as appliances, drums, sacks, and materials. Gloves and safety shoes should be worn when working with this equipment. Two-wheeled hand trucks (Figure 8) should be equipped with knuckle guards to avoid hand and finger injuries. Wheels should be as far under the truck as possible and wheel guards should be provided. These procedures must be followed to avoid injury:

1. The load should be tipped forward slightly so the tongue of the truck goes under the load.
2. The truck must be pushed all the way under the load.
3. The center of gravity of the load should be kept as low as possible.
4. Care must be taken so the load will not slip or shift. Straps may be necessary to hold the load.
5. The operator should only balance the load; the truck is designed to carry the load.
6. The operator should not walk backwards with a hand truck.
7. When going down an incline, the truck should be ahead of the operator.

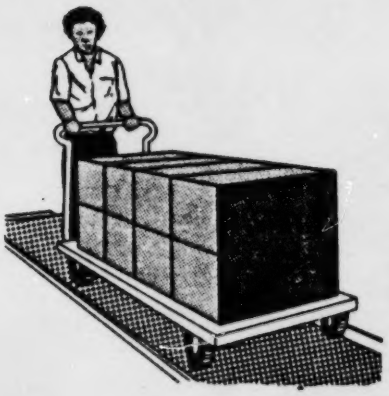


Figure 9. Four-wheeled hand truck.

The four-wheel hand truck (Figure 9) performs jobs similar to the two-wheel hand truck, and similar rules govern their use. Loads must be evenly distributed to avoid tipping; operators must not load trucks so high that they cannot see over the load; handles must be placed in a protective spot so fingers will not be pinched when operators are going through doorways.

PALLETS

Pallets are usualy constructed of wood, fiberglass, or plastic. They must be kept in good repair to avoid splinters or weaknesses that could result in a stacking failure. Pallets must not be stacked on end because of the dangers of a tipped pallet's striking a worker's feet and legs. Storage of pallets can create a serious fire hazard. Pallets should not be stacked at heights greater than six feet because sprinkler systems cannot develop an effective spray when materials are stacked at greater heights. In addition, the underside of the pallet creates a dry area with enough available oxygen to promote a fire. Such a fire is difficult to control, because water from sprinklers is blocked from extinguishing the fire within the horizontal stringers.

ACTIVITY 6:

1. State at least one precaution required for the safe use of each of the following tools.
   a. Pry bar _____
   b. Hand hook _____
2. Complete the sentences below to make a true statement about safe procedures with hand trucks or pallets.
   a. The operator should not walk _____ with a hand truck.
   b. When going down an incline, the truck should be _____.

c. Operators must not load trucks so high that they _____.

d. Pallets must not be stacked higher than _____ _____.

OBJECTIVE 7: Identify the hazards of three types of powered material handling equipment.

POWERED INDUSTRIAL TRUCKS

Powered industrial trucks are used extensively in industry. They are powered by electric batteries or by gasoline, propane, or diesel fuel. Electrical units are preferred in many installations because of their quiet, pollution-free operation. When powerful lifting requirements are necessary, gasoline, propane, or diesel units are usually preferred. Special vehicles are available for use in atmospheres where explosive dusts or flammable vapors are a hazard. The principal types of powered equipment are listed and described below.

Rider-operated trucks are high-lift or low-lift trucks that use a platform with vertical uprights and an elevating mechanism to lift and store loads. High-lift trucks are capable of stacking loads to a height in excess of 25 feet. Variations of rider-operated lift trucks may use a horizontal ram for handling rolls, coils, and carpeting. Clamp trucks handle round shapes such as paper rolls. Vacuum systems grasp materials by engaging and holding the object during transport. Long materials are transported by straddle trucks, while other vehicles perform specialized tasks with scoops, blades, and buckets.

Motor hand trucks (platform trucks with elevator forks) are used by a walking operator for transporting low loads, and may be used for lifting products into storage areas. The brakes work automatically when the handle is in the fully raised or fully lowered position. Controls must be clearly marked and operators must be trained to avoid being pinned against a load, barrier, or wall. Guards on hand controls and on wheels will protect workers.

Remote controlled trucks are operated electronically without guidance from an operator. These trucks are equipped with horns, lights, and buzzers,

and with bumpers that will shut off power and stop movement if they are contacted.

Many injuries involving power trucks result from failure to maintain safe equipment, to train operators adequately, or to supervise properly. The stability, capacity, and utilization of equipment must be determined when selecting material handling aids.

Power trucks cause property damage as well as injuries. Statistics on power truck accidents indicate that when workers come in contact with vehicles, the accident is costly both in human and economic terms. A study of 15,000 cases at Deere and Company disclosed that 1% of these cases (or 150 injuries) involved lift trucks. This 1% of injuries involved 10% of the disabling injuries reported in the 15,000 accidents.

Operators of powered industrial trucks must be trained in the operation of the vehicle. Training must include classroom and on-the-job instruction Drivers must be physically fit and meet vision, hearing, coordination and reaction standards. In addition, operators must be familiar with safe practices for refueling, with the capacity and capabilities of the vehicle, and with its operation. Safety procedures must be observed if injuries are to be prevented.

CONVEYORS

Conveyors are used to move bulk materials, packages, and partially assembled products to or through the manufacturing process. Conveyors may be belt, slat, chain, screw, bucket, pneumatic, aerial, portable, gravity, live roll, or vertical types. All gears, sprockets, sheaves, and rotating parts of conveyors must be guarded to prevent workers from contacting pinch points or being pulled in toward the machinery by hair or clothing. Warning signs, lights, and interlocks warn and protect workers from accidental movement or operation.

CRANES AND HOISTS

Overhead and gantry cranes are used extensively in construction and in manufacturing plants to move heavy equipment and materials. All parts of such equipment that are subject to wear must be inspected regularly, with monthly

written reports completed on critical items such as brakes, hooks, and wire ropes. (OSHA 1910.179 and 180 provide inspection and personnel training requirements.)

Electric, air, and hand operated hoists are used to raise, lower, and transport heavy loads for limited distances. Thousands of hoists are used in industry to move materials, equipment, and parts. Safety factors regarding inspections and training must be followed to ensure safe operation. Cable, hook, and operating controls must be inspected regularly to avoid equipment failure. Workers must never walk or stand under suspended loads since equipment failure or the lowering of loads could cause accidents. Most lift capacities must never be exceeded or equipment failure may result.

ACTIVITY 7:

State one type of accident that can occur during the use of the equipment listed below.

1. Powered industrial trucks _____
2. Hoists _____
3. Conveyors _____

OBJECTIVE 8: Discuss the impact of good housekeeping and orderly planning of storage areas on fire protection and emergency evacuation.

The orderly planning of storage areas reduces the probability of injuries to workers and allows for swift and safe evacuation in case of emergencies.

To maintain a hazard-free work environment, loading docks, railroad sidings, floors, ramps, aisles, lighting, stairs and elevators must be kept in good condition. Sufficient clearances should be provided in aisles and work areas. Load limits of elevators, floors, and ramps must be observed. Fire regulations require that aisles be kept free of goods or loose combustibles. Aisles must be well defined and marked, and exits must be indicated and cleared for evacuation in the event of fire. (See Figure 10.)

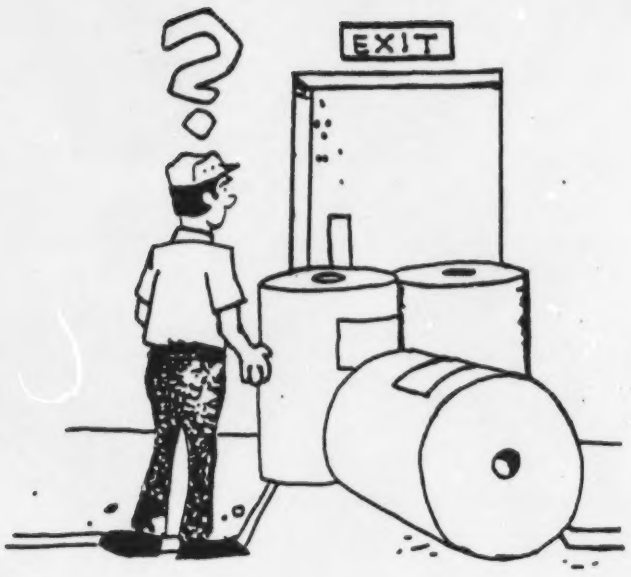


Figure 10. Exits must not be blocked.

Housekeeping standards must ensure that electrical and sprinkler controls are not blocked. Hose stations, extinguishers, and personal protective equipment lockers must be available. Regular inspections will ensure that equipment is ready for emergency use. Exit signs must be visible, available to occupants, and never blocked. Good housekeeping in storage areas avoids slipping, tripping, and fire hazards.

While fire regulations call for 18" to 24" clearances from material to sprinkler systems, the Factory Mutual Insurance Group suggests a clearance of 36" from sprinkler heads to material storage. This ensures that sprinklers will have room to develop an effective water spray pattern in the event of fire. Fire officials suggest a 15-foot clear space between storage sections so that fire fighters will have access to the fire.

Fire protection and control equipment must be well identified. Where power trucks could damage interior fire system controls, sprinkler lines, or standpipes, protective barriers should protect fire equipment.

Sprinkler protection and automatic closing of fire doors to seal off sections of the plant during a fire saves lives and property. "No Smoking" rules must be observed in warehouse storage areas where few workers are assigned and where the discovery of fire may be delayed. One out of every five industrial fires is attributed to smoking or to the careless use of matches. By controlling smoking, by avoiding careless storage of flammables, and by removing loose combustibles, the threat of fire loss is minimized.

When these good work practices are instituted and routinized, retrieval will be easier and more efficient, and stock damage will be reduced. These benefits will occur in addition to the increase in safety.

ACTIVITY 8:

1. Sprinkler heads should be at least _____ to _____ inches from the material stored below to allow for an effective water spray.
2. Fire regulations require that loose _____ be removed from aisles, ramps, and exits.
3. Exit signs should be _____, available to occupants, and never blocked.
4. "No Smoking" rules must be observed in warehouse storage areas where _____ workers are assigned.

OBJECTIVE 9: Describe the general requirements for floors, ramps, and aisles in a warehouse.

The transport and arrangement of materials in a warehouse is critical to worker safety, so guidelines have been established to regulate these factors. Floors and aisles in warehouse storage must be level. Cracks, and uneven and broken surfaces must be repaired for the safe operation of power equipment and for pedestrian traffic. Floor load capacities must be posted and load limitations observed. Aisles must be unobstructed for easy access to stock, and to reduce fire and safety hazards.

A further factor in warehouse safety is the manner in which stock is stored. Storage height limitations must be observed; yellow lines at maximum heights indicate how high materials may be stacked. Nothing can be stacked safely unless workers start with a level base. Crosstying or interlocking piles provides stability. Dunnage or timbers can be used to prevent a stack from shifting. The toppling of a load could result in a serious injury to a power truck operator or a worker in the area.

Ramps, while invaluable, provide more opportunities for accidents, so certain rules should govern them. Ramps should be coated with nonskid surfaces and have sufficient room for two-way traffic. Safety provisions must be made to reduce hazards resulting from wet, icy, or snowy conditions on

outside ramps. Curbs should be used to reduce the possibility of a power truck's sliding off a ramp. Scrap material, spills, and obstructions must be removed from traffic areas. Curbs and dock edge guards should be used to prevent power trucks from being accidentally driven off ramps or docks. Magnesium or heavy timber dock edge guards provide excellent protection at railcar docks.

Mirrors should be placed at blind intersections to prevent collisions and warn power truck operators of traffic. Warning signs, lights, and visual reminders are additional accident prevention measures that should be used to reduce accidents. Warning devices on powered vehicles should be used to warn workers of their presence.

ACTIVITY 9:

Describe the general requirements for floors, ramps, and aisles in warehouse areas by completing these statements.

1. Floors must be _____.
2. Aisles must be _____.
3. Ramps should be coated with _____ surfaces.

OBJECTIVE 10: : Name the source of lighting standards for industrial lighting.

Many loading, unloading, and storage operations are performed in areas where lighting and heating are kept to a minimum. However, safe work requires adequate light, and around-the-clock operations and inside storage require supplemental illumination. OSHA regulations have adopted the American National Standards practice for industrial lighting. The standard provides guidance on lighting necessary for operating and storage areas. ANSI Standard A 11.1-1965 requires lighting of adquate intensity to perform various tasks. Following (in Table 1) are levels of illumination in warehouse storage and retrieval areas. Dock lighting, portable railcar, and supplemental illumination may be required to safely perform storage, loading, and retrieval jobs. Lighting on power lift trucks is frequently required to perform loading and storage activities.

TABLE 1. LEVELS OF ILLUMINATION REQUIRED IN WAREHOUSE AND RETRIEVAL AREAS.

Storage Rooms	Footcandles* on Tasks
Inactive areas	5
Rough bulky stock	10
Medium stock	20
Fine stock	50
Picking stock, classifying	30
Loading, trucking	20
Railcars	10

*A unit of illumination, equal to the illumination of a surface, all points of which are at a distance of one foot from a source of light equal to one candle.

Factors other than lighting must be considered when discussing material handling done by power trucks. Care must be taken to protect workers from excessive carbon monoxide (50 parts per million) that can result from powered industrial truck operation. Confined spaces such as railcars and trailers are hazardous during loading and unloading operations. Periodic monitoring for carbon monoxide levels, particularly during cold weather when plant doors are closed, is necessary. Powered trucks must be maintained in good operating condition to minimize the carbon monoxide hazard. Air changes and air movement will reduce problems associated with carbon monoxide.

ACTIVITY 10:

Name the source of lighting standards for industrial lighting. (Check one.)

1. ___ National Fire Protection Code.
2. ___ ANSI Standard A 11.1-1965.
3. ___ OSHA Standard 1910.178.

OBJECTIVE 11: : Compare the use of racks and bins for warehouse storage.

Once stock is transported to storage areas, an efficient means of storing it must be determined. Unpackaged stock is often stored in stock bins to be

readily available for use in the manufacturing process or as parts are required. Heavy metal parts in bulk storage require mechanical handling equipment for efficient transport.

Mechanized high bay storage systems use uniform racks for storing goods and parts. In these systems, storage is usually packaged and unitized in standard size cubes. For the protection of workers who operate and maintain rack storage facilities, visual and audible warning devices should be included on lift equipment transporting goods to rack storage.

Computer-operated automated warehouses usually handle standard size racks. Workers deliver rack-size packs or pallet loads to the automated drones (robot trucks) that move products horizontally and vertically to the correct storage slot. Computers maintain inventory records and retrieve goods when needed. Only maintenance workers are required to occasionally perform work in such automated storage warehouses.

ACTIVITY 11:

Compare the use of racks and bins for warehouse storage.

_____

_____

_____

OBJECTIVE 12: : Cite specific storage procedures for the following: boxes and cartons, barrels and kegs, rolled paper and reels, compressed gas cylinders, uncrated stock, and hazardous materials.

Boxes and cartons or cube-sized uniform packs used in storage warehouses, are frequently packaged in corrugated shipping containers, or unitized so that they can be handled by power equipment. If racks are not used, height limitations are necessary because compression of the product packaging will result in damage and unstable stacking. Boxes and cartons are frequently stored on pallets for convenient power truck handling and for protection from moisture. Interlocking of non-rack storage provides stability and reduces the possibility of material falling.

Barrels and kegs must be stacked in a stable manner. A pyramid stacking arrangement, with bottom rows blocked to prevent rolling, is preferred. If barrels or kegs are stacked on end, planks should be placed between rows unless specially constructed racks are provided.

Rolled paper and reels are most easily handled by roll grab power trucks. Care must be taken to stack rolls on end and to keep them even. Paper rolls should be banded at top and bottom to prevent damage and reduce the defoilment of paper during a warehouse fire.

Compressed gas cylinders should be handled and stored in an upright position. Bumping, dropping, or jarring of cylinders must be avoided. Cylinders must be stored upright in approved areas with chains or cables to support them. Oxygen and acetylene cylinders must be stored at least 20 feet apart (Figure 11), or separated by a fireproof wall at least five feet high and

Figure 11. Stored oxygen cylinders are separated from stored fuel gas cylinders or combustible materials by a minimum distance of 20 feet or by a fireproof wall.

having a one-half hour fire resistance rating. When cylinders are moved from one level to another they must be placed in a cradle or platform device. Valves must be kept closed and protective caps must be secured in place.

Lumber is usually separated by lengths and size and stored outside in a covered area. Firm, well-drained storage areas are necessary for outside storage. For long-term piling, concrete with solid footings will provide dry storage. If lumber is to be removed by hand, low racks or piles with ties to provide ventilation and stability should be utilized. Lumber stored inside a building should have good ventilation. Workers must wear hand protection during lumber handling jobs.

Bagged materials should be crosstied with the open end of bags toward the inside of storage piles. If piles exceed five feet in height they should be stepped back one row for additional piling. They should be stepped back one row thereafter for each additional three feet of storage height to provide stable, orderly storage.

Pipes and bars place a heavy load on floor capacities. Floor load limits must be determined to ensure that floor supports will withstand the weight requirements of these materials. Pipes and bars must be piled in layers with wood strips between layers, since they may slide or tumble, causing serious worker injuries. If pipes or bars do roll, workers should never try to stop them. Trying to stop rolling pipes is usually disastrous and may result in fractures to limbs.

Sheet metal requires racks similar to those used for bar storage. Since sheet metal has sharp edges, workers must wear leather gloves, or gloves with metal inserts, when handling it. Injuries from cuts can be reduced if stacks of sheet metal stock are banded, or wooden stakes are put around the stack.

Burlap sacking storage areas should be constructed of fire-resistant material, and protected by a sprinkler system. Sacks should be piled in low stacks, and the interior of the piles should be ventilated to permit airflow from the outside of the pile to the center.

Straw, excelsior, and other packing materials are usually stored in bales. Fire-resistant rooms with sprinkler protection are necessary for their bulk storage. The amount of materials should be limited. The use of material bins with covers will minimize the quantity of fuel exposed, and fusible links on the covers of the bins will ensure closing during a fire.

The storage of flammable and toxic liquids presents a variety of hazards to the safety specialist. The weight of tanks and the liquids contained in tanks must be considered in building design and the designation of storage areas. Large tanks should be located away from traffic areas, and should have permanent stairs and ladders for access. Tanks must be grounded, bonded, and have adequate venting, and must be inspected regularly. The filling and cleaning of tanks must be performed in accordance with well defined job instructions. Personal protective equipment including gloves, eye protection,

clothing and respirators may be necessary when handling flammable or toxic liquids. Material data safety sheet precautions must also be observed when handling such liquids.

When flammable solvents are used, the quantities in plant work areas must be kept to a minimum. Solvents must be stored in flammable storage rooms or in buildings located apart from the manufacturing facility. A suggested storage room with safety features is shown in Figure 12.

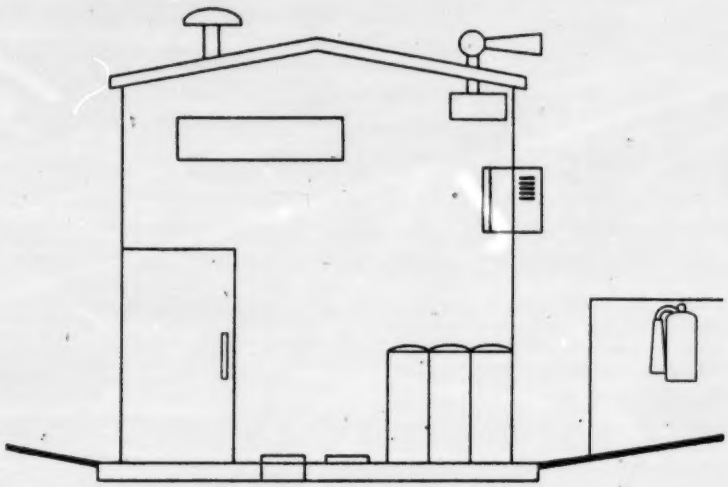


Figure 12. Flammable storage shed located away from areas of fire hazard. Flammable solvents are isolated from areas of fire hazard. Flammable solvents are isolated from oxidizers, explosives, ignition sources and chemicals capable of spontaneous heating.

Portable safety containers with flame arrestors, approved by Underwriters Laboratory, must be used in the plant for small quantities of highly flammable liquids. Large supplies of flammable liquid must be isolated from the plant by fire walls, fire doors, drainage, explosion-proof lighting, bonding, and grounding (Figure 13). Drums should not be stacked, but contained in racks, or separated. Equipment designed for safe handling and transporting of barrels must be used.

Tank cars should be isolated on sidings and the Blue Flag Policy (see page 33) followed during unloading. Brakes must be set, and wheels must be

Figure 13. Bonding and grounding in well-ventilated storage areas is essential protection against fire or explosion.

chocked. Tank cars must be bonded, and connections checked regularly during unloading. Unloading connections should be through the dome rather than through the bottom connection. If contents are nonflammable, air pressure not exceeding 25 pounds per square inch may be used during unloading. Tank car unloading procedures must be carefully followed if disastrous consequences are to be avoided.

Bulk storage bins store large quantities of materials that flow, or that are conveyed for processing. Vibrator units are frequently used to ensure flow and to reduce the need for workers to enter bins to free material. Workers must follow lockout and confined space procedures if they must enter bulk storage bins, since accidents involving this type of equipment may result in a fatality.

Combustible solids such as coal, grain, starch, and sugar dust can cause serious explosions. Wiring, lights, and switches must meet National Fire Protective Codes for hazardous locations. Electric motors must be the totally enclosed, explosion-proof type with well-protected bearings. Indirect heating should be used and "No Smoking" rules rigidly enforced. Static electricity must be controlled and grounding used. Automatic sprinkler protection may be helpful. Cleanliness and dust removal on a regular basis will reduce the buildup of combustible dust and the threat of an explosion.

Portable containers (50 and 100 pound bags or containers of solid materials) must be handled carefully to prevent sifting or leaking. Interlocked storage should be used for greater stacking stability. Water damage must be avoided during storage and handling, and bags must be protected from moisture and weather. Ventilation may be required to reduce storage hazards. Workers who handle toxic materials and chemicals must be made aware of health hazards. Such workers should wear personal protective equipment to avoid breathing dust particles and to eliminate skin contact.

Explosives must be stored in magazines of approved construction. Federal, state, local, and NFPA codes provide specifications for the handling and storing of explosive materials:

- They must be stored under lock and key and records must be maintained.
- Floors must be kept clean.
- No matches or flammable materials may be used in the area.
- Wooden floors with no exposed nail or bolt heads must be provided.
- Only portable, approved lighting is permitted in clean, dry, well-ventilated storage magazines.
- Workers performing storage and handling of explosives must follow all the rules and procedures that such storage requires.

ACTIVITY 12:

List one specific storage procedure for each of the following.

1. Boxes and cartons _____
2. Barrels _____
3. Rolled paper and reels _____
4. Compressed gas cylinders _____
5. Uncrated stock _____
6. Hazardous materials _____

OBJECTIVE 13: Briefly describe stock picking and carloading safety.

STOCK PICKING

Sequence picking of component parts (for final assembly) from storage racks or bins has increased the use of high bay storage. Workers operating

a mobile order-picking truck are exposed to heights and falling objects. During stock picking operations, workers may be required to climb ladders to obtain small parts or stock, so standard guard rails and brakes on movable ladders are necessary to avoid injuries. Workers must not climb racks, or use step ladders. Only properly designed, heavy-duty material handling equipment should be used in stock picking operations.

Where fully automated trucks (drones) are used to place and remove stock in automated storage warehouses, no workers should be permitted in rack areas when equipment could cause an injury. Maintenance work must be performed after lockout procedures have been verified.

CARLOADING

Thousands of railcars are loaded and unloaded daily. According to a New York State study of railcar injuries, 55% of the injuries resulted from worker falls. Of these, 17% resulted from slips, and another 17% occurred when workers were struck by a vehicle, or by the object being moved. The study disclosed that three-fourths of railcar injuries involved in loading and unloading operations were to the lower extremities or trunk.

To make loading of railcars safe, it is important that railcars be inspected before loading. Chemicals, debris, damaged floors and sidewalls are reasons for rejecting a car. Desirable railcars should have smooth sides, and floors with water-tight roofs. Nails and protruding objects must be removed from floors and side walls. Workers performing unloading and loading need foot protection. While working around steel strapping or dusty conditions, eye protection is necessary. Gloves may be required in some instances.

Management must ensure that switching will not occur while workers are in railcars. This is accomplished by following the Blue Flag Policy (spelled out in OSHA-1910.261 (c) 9iii) that states:

- The Blue Flag Policy shall be used to mark stationary cars day and night. This policy shall include marking the track in advance of the spotted cars (flag for daytime, light for darkness).
- Warning flags or signs shall be placed in the center of the track at least 50 feet away from the cars and a derail set to protect workmen in the car.

The rule book for the railroad will not permit an engine crew to enter a track where they see a blue flag. It does not matter what the blue flag says; it could read, "Derail,...Tank car connected" or "Men at work." The switch crew must not lower or remove the blue flag sign unless they have placed it for their purposes.

Derails are fastened to the rail track to divert other cars that may be inadvertently switched before workers have left a car in which they are working. The responsibility for the derail depends on its directional placement on the rail track. It may be placed by the railroad crew to prevent a railcar on a siding from entering an active track, or it may arise from a plant's effort to prevent a railroad crew from inadvertently switching while workers were in the car. Before loading or unloading cars, it is necessary to set the brakes and chock wheels (Figure 14).

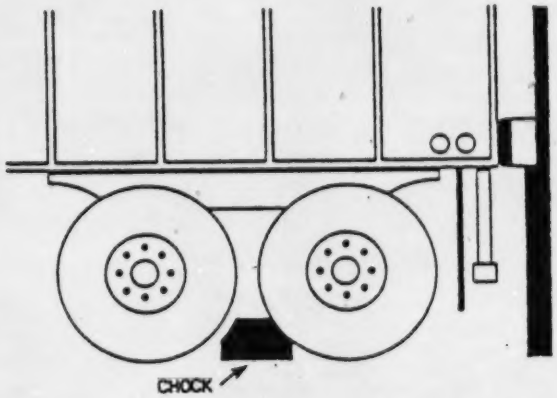


Figure 14. Trailer wheels must be chocked at docks to prevent movement.

Since powered lift trucks are commonly used to unload railcars, dockboards to be used must meet certain requirements. Dockboards should be designed to carry four times the heaviest load capacity expected, and they must have a nonskid surface. The sides should be turned up at a 90° angle to keep the powered lift trucks from running off the edges. Injuries have occurred when power trucks are driven off docks between trailers and docks, so dock edge guards, or 8" x 8" timbers fastened to the dock edge should be used. These guards reduce the possibility of trucks driving off docks accidentally. Dock edge guards and dockboards must be secured in position to prevent slipping or rocking.

ACTIVITY 13:

Briefly describe stock picking and carloading safety.

_____

_____

_____

_____

_____

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ANSWERS TO ACTIVITIES

ACTIVITY 1

1. Strains – stretching a muscle beyond its proper limit.
2. Sprains – weakening of a joint and related muscles by sudden or excessive exertion.
3. Hernias – protrusion of an organ (often the intestines) because of a pulling apart of the body's muscle lining.
4. Fractures – broken or cracked bones.
5. Wounds – bruises and cuts.

ACTIVITY 2

1. Size, shape, and condition of the load.
2. Capability required to lift the load.
3. Path to the load, clearances.
4. Personal protective equipment.

ACTIVITY 3

1. b.
2. b.

ACTIVITY 4

1. b.
2. Safety toe, conductive, electrical hazard, nonsparking, and foundry.
3. a. 75.
   b. Z 87.1-1979.

ACTIVITY 5

1. False.
2. True.
3. True.
4. False.
5. True.

ACTIVITY 6

1. a. Pry bar — should not be used to move railcars.
   b. Hand hook — if carried on belt, point should be protected.
2. a. Backwards.
   b. Ahead of the operator.
   c. Cannot see over the load.
   d. Stacked higher than six feet.

ACTIVITY 7

(One of each.)

1. Operators pinned against load, barrier, or wall.
2. Workers hit by lowering loads or dropped loads.
3. Workers caught in pinch points or pulled toward machinery by hair or clothing.

ACTIVITY 8

1. 18" to 24"
2. Combustibles.
3. Visible.
4. Few.

ACTIVITY 9

1. Level.
2. Unobstructed.
3. Nonskid.

ACTIVITY 10

2. ___ A 11.1-1965.

ACTIVITY 11

Bins are used for unpackaged parts storage while rack (high bay) storage is usually used for packaged goods.

ACTIVITY 12

1. Boxes and cartons are generally stored on pallets or unitized.
2. Barrels are pyramid stacked on sides with blocking to prevent rolling.
3. Rolled paper is generally stacked on end by roll grab trucks.
4. Compressed gas cylinders are stored upright and carefully handled.
5. Uncrated stock must be stacked in a stable manner and crosstied to avoid toppling.
6. Hazardous materials must be kept in approved containers in small quantities in the plant. Larger quantities must be stored in well-designed fireproof lockers or storage rooms.

ACTIVITY 13

Stock picking is the removal of parts from rack or bin storage for assembly operations or parts shipments. Workers must use assigned equipment and not climb on racks or use step ladders. Carloading safety includes car selection, chocking, personal protection, and Blue Flag Policy.